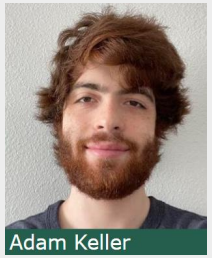
LeafIt!

Automatic Irrigation System

GROUP 9

THE TEAM



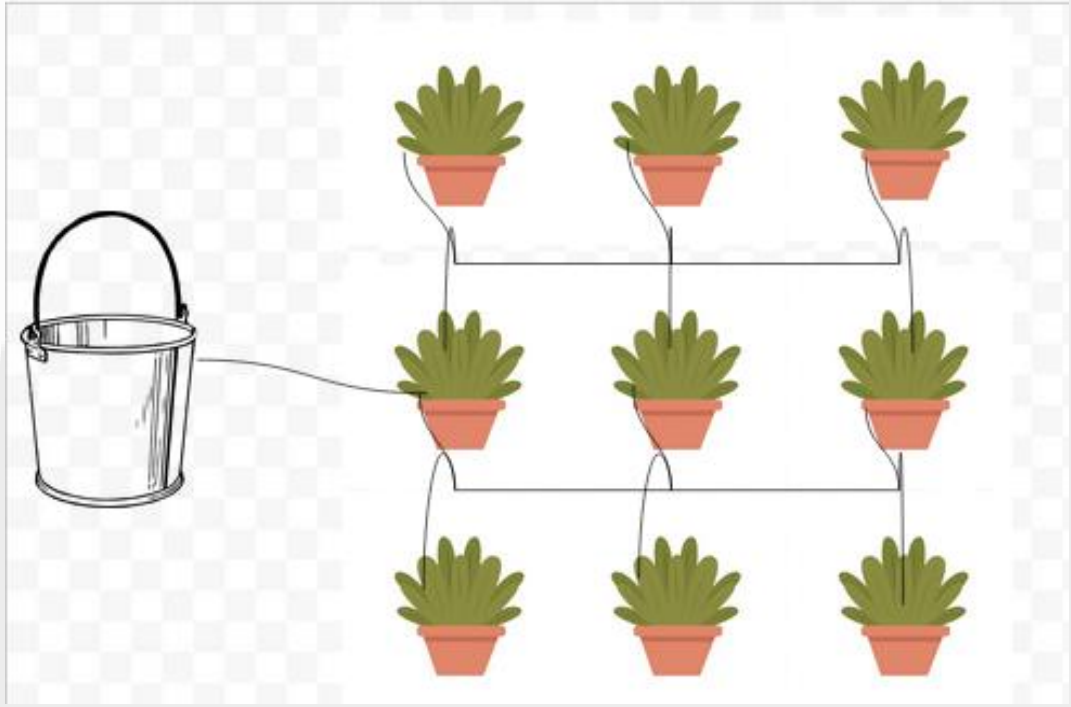
			
Kyle Eaton Electrical Engineering	Adam Keller Computer Engineering	Francis Olearczyk Electrical Engineering	Matt Ongcapin Computer Engineering

MOTIVATION

- The motivation behind this project was due to the death of several houseplants after returning from vacation.
- Given the emergence of the Internet of Things we felt it was a great combination of using a website/app to record and show sensor data from a distance using soil and temperature sensors.

GOALS & OBJECTIVES

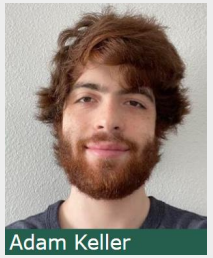
- The system shall automatically water one outdoor plant using a water pump with amounts of water based on one of the three possible types of plants that the user inputs, the temperature, and the moisture present in the soil of the plant.
- The system shall have two sensors to monitor soil moisture of the plant and temperature.
- The system shall use a water pump to draw water from a reservoir of water outside of the system i.e., a bucket or pot of water.
- The system shall have a web interface for users to choose soil moisture and temperature settings based on three types of plants.
- The system’s watering and temperature settings shall be based on three types of plants: Tropical, Temperate, and Cactus/Succulent.



ENGINEERING SPECIFICATION

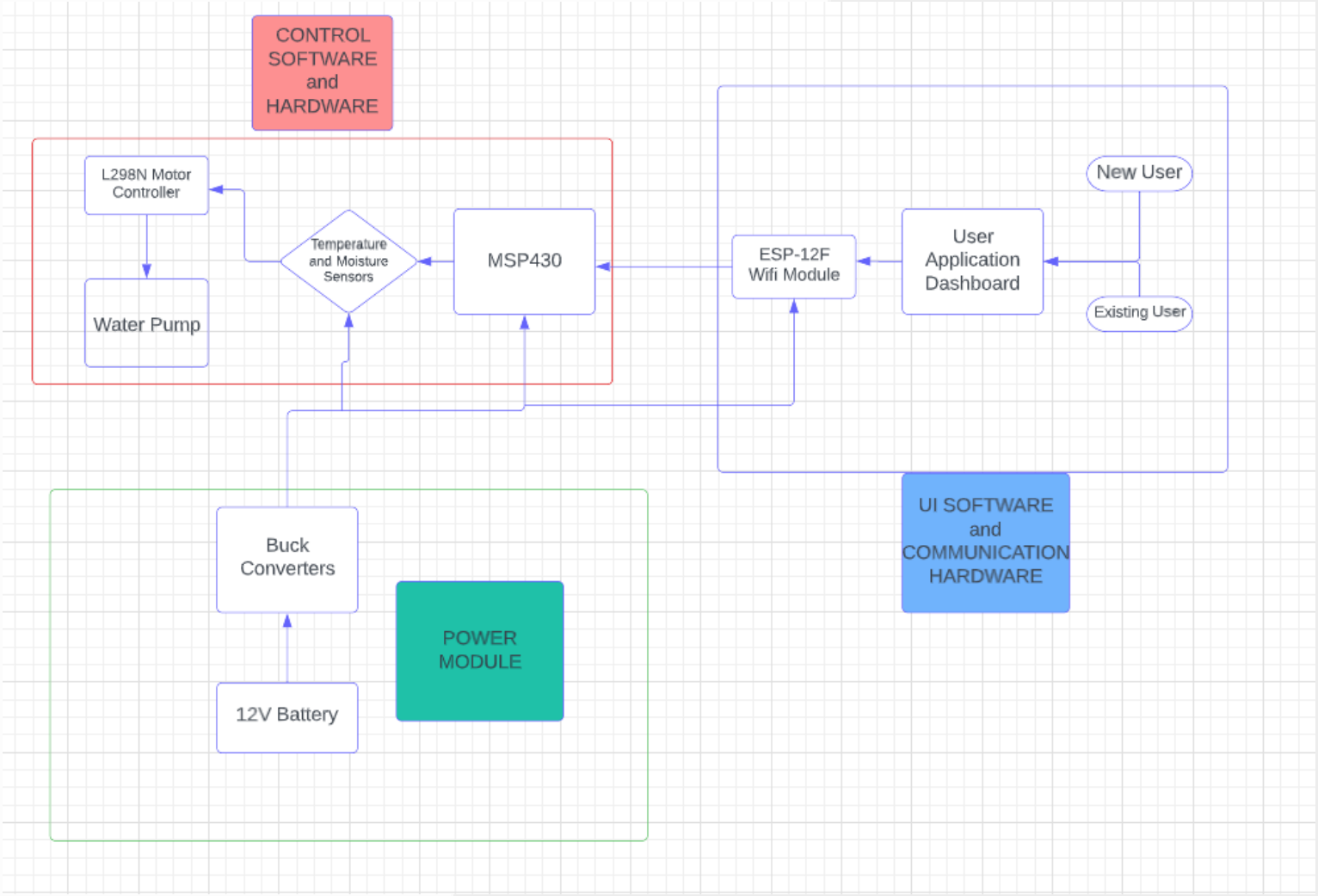
Engineering Specifications	
Watering	Pump will provide 30mL-50mL of water in less than 5 minutes
Volume	Product will not be taller than 2ft x 3ft x 2ft
Cost	Product will not cost more than $250
Power	Product will not use more than 24kWh and be able to produce 12V, 5V and 3.3V
Temperature sensor	Product will accurately measure temperatures between 0C and 40C with an accuracy of 0.75C
Moisture sensor	Will detect in 1cm^3 of soil of a 5mL difference of water saturation
Web Server: Long term statistics	The web server will record values received from the MCU every 5 seconds

WORK DISTRIBUTION

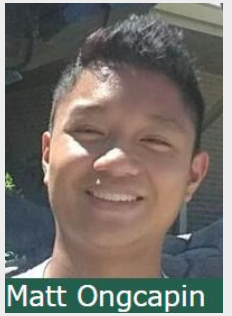


	Power	Sensors	MCU	Website/Phone
Primary	Kyle	Francis	Matthew	Adam
Secondary	Francis	Kyle	Adam	Matthew

FUNCTIONAL BLOCK DIAGRAM



SUBSYSTEMS & COMPONENTS

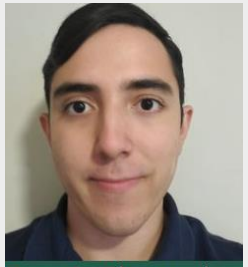


HARDWARE SUBSYSTEM	SOFTWARE SUBSYSTEM	POWER SUBSYSTEM

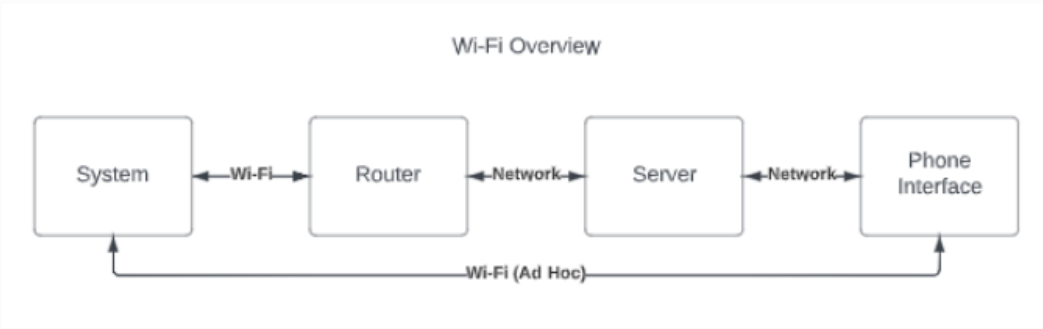
• Control Unit Components
  • Microcontroller
  • Motor/Pump Controller
  • Wi-Fi Module
• Moisture Sensor
• Temp Sensor
• Motor/Pump Controller
• Water Pump
	• Web Interface Components
	  • User Interface Tool
	  • Web Stack
	  • Databases
	  • Hosting Platform
	• Control Software Components
	  • IDE
	  • Language
		• Batteries
		• Buck Converters

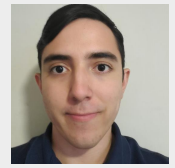
HARDWARE SUBSYSTEM

WIRELESS COMMUNICATION



- Can use Wi-Fi or Bluetooth
- Scope includes being able to connect at long distances
- This rules out Bluetooth, as it is a short-range peer to peer connection





WIFI AND BLUETOOTH

Part	Interface	Protocol	Special Feature	Cost
ESP-01	SPI, UART, I2C	b/g/n	Simple	3$
ESP-12F	SPI, UART, I2C	b/g/n	Easy to interface	2$
ESP32	SPI, UART, I2C	b/g/n	Advanced processor, Bluetooth	4$
CYBLE-333074-02	SPI, I2C	4.2	1Mbps	11$
NINA-B221-03B	UART	4.2	1Mbps	13$
BGM220SC22HNA2R	SPI, I2C, UART	5.2	2Mbps	10$

WATER PUMP

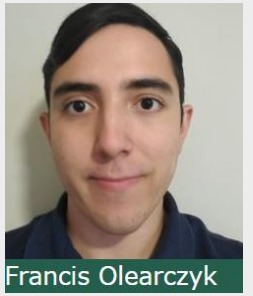
Feature	12V Mini Brushless	Sipytoph	LEDGLE Mini USB
Voltage (Volts)	12	3 - 5	5
Amps (Milli-Amps)	600	180	300
Price Per Unit ($)	15.96	2.85	11.58
Estimated Throughput (Liters/minute)	2.2	2	3

MOTOR CONTROLLER

Feature	Icstation	L298N	Cytron
Input Voltage (Volts)	2.2-5	5-25	5-25
Motor Current (Amps)	5	2	13
Temperature Range (Celsius)	-20 - 135	-20 - 85	NA
PWN (Y/N)	Yes	Yes	Yes
Dual Motor	Yes	Yes	No

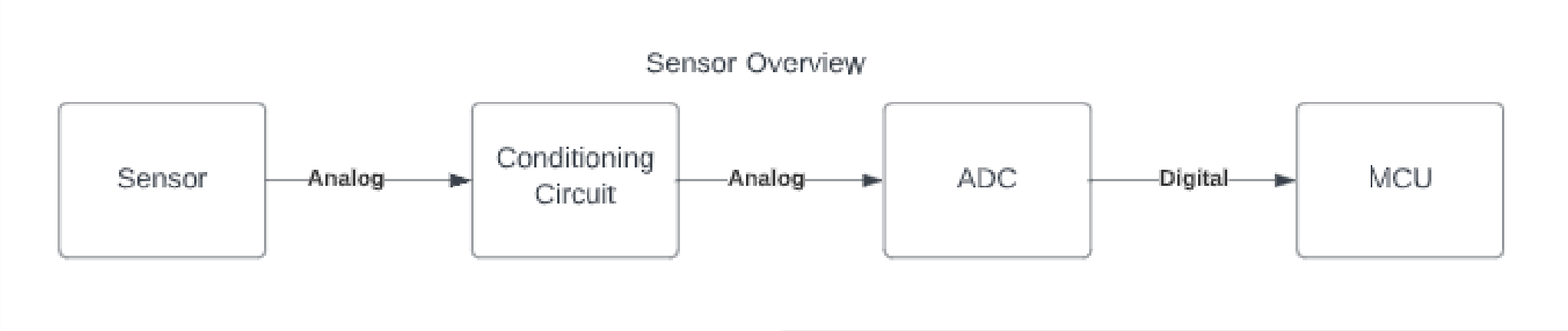
BATTERY

	Tenergy 12V	ExpertPower 12V	Amazon 9V
Voltage (Volts)	12	12	9
Electric Charge	2000	5000	481
Rechargable (Y/N)	Yes	Yes	No

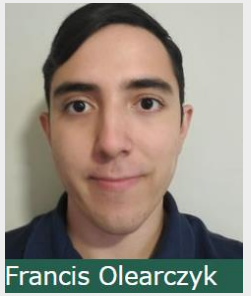


SENSORS

- Soil moisture sensor
- Temperature sensor
- How complex do we want these sensors?

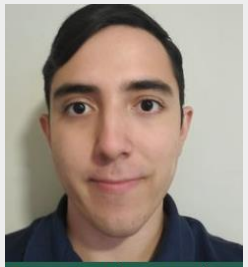


MOISTURE SENSOR



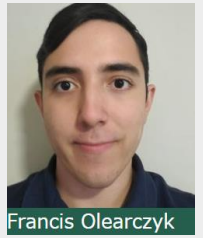
- Primarily two types: capacitive and resistive
- Soil Moisture sensors degrade quickly and can be unreliable
- Analog or digital?

SOIL MOISTURE SENSOR



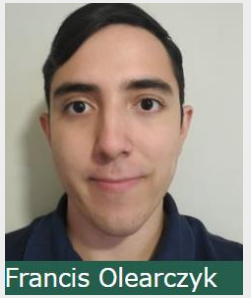
Part	Interface	Type	Special Function	Cost
STEMMA	I2C	Capacitive	temperature sensor	8$
PR46-7	I2C	Resistive	-	30$
Songhe	analog	Capacitive	-	2$

Soil Moisture Sensor: Calibration



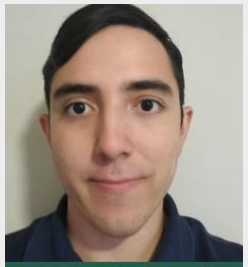
- The information received from the SMS will be processed into a percentage
- First the ambient air with the SMS dry will be recorded as the lowest possible moisture
- Next, the SMS will be placed in a cup of water, and the value returned will be the max amount of moisture
- The moisture of the soil will be returned as a percentage between the max and min values

Temperature Sensor



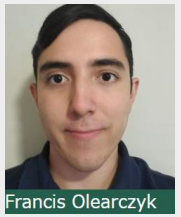
- We want the sensor to be accurate within 0.75C
- Analog or digital?
- Do we want any special features?

TEMP SENSOR PART SELECTION



Part	Interface	Accuracy	Special Function	Cost
MCP9808	I2C	0.25C	alert pin	5$
TMP275	I2C	0.5C	alert pin	3$
TMP112X	I2C	0.5C	Alert pin	3$
TMP126	SPI	1C	alert pin	2$
LM92	I2C	1C	alert pin	6$
BME280	I2C OR SPI	1C 1hPa 3%humidity	Measures Pressure and Humidity	15$

MICROCONTROLLER



Part	Pins	Clocks	ADC	Cost
MSP430FR247x (MSP430FR2475TRHBT)	40	6	12-bit	6$
MSP430F552x	47	4	12-bit	7$
MSP430FR6989	83	6	12-bit	20$
PIC24FV16KM204	44	2	80bit, 12-bit	4$

POWER SUBSYSTEM

POWER

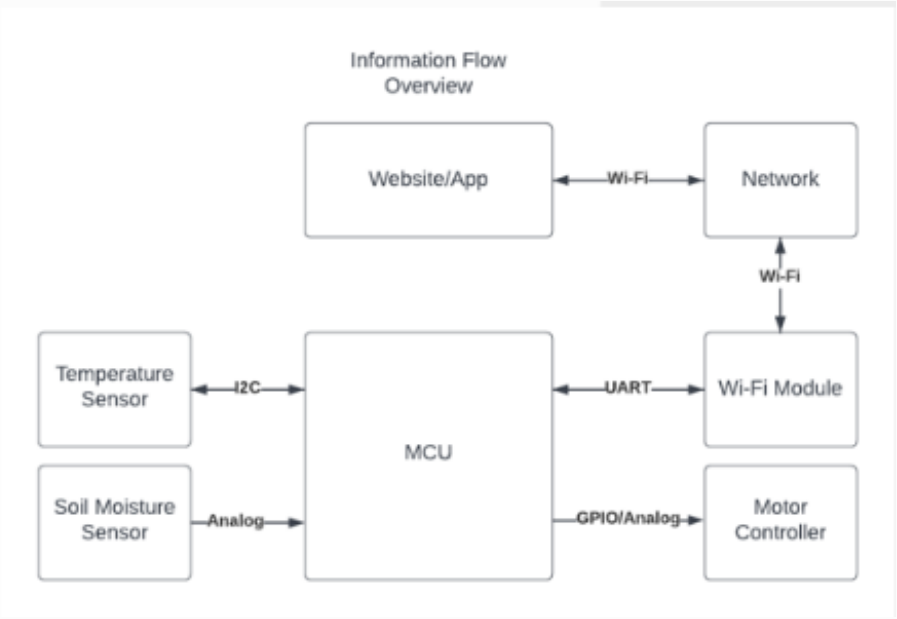
- Battery Powered
- Can power all electronics for extended periods of time
- Rechargeable
- Reasonably sized due to our project weight constraints of:
  - The system shall not weigh more than 3 pounds

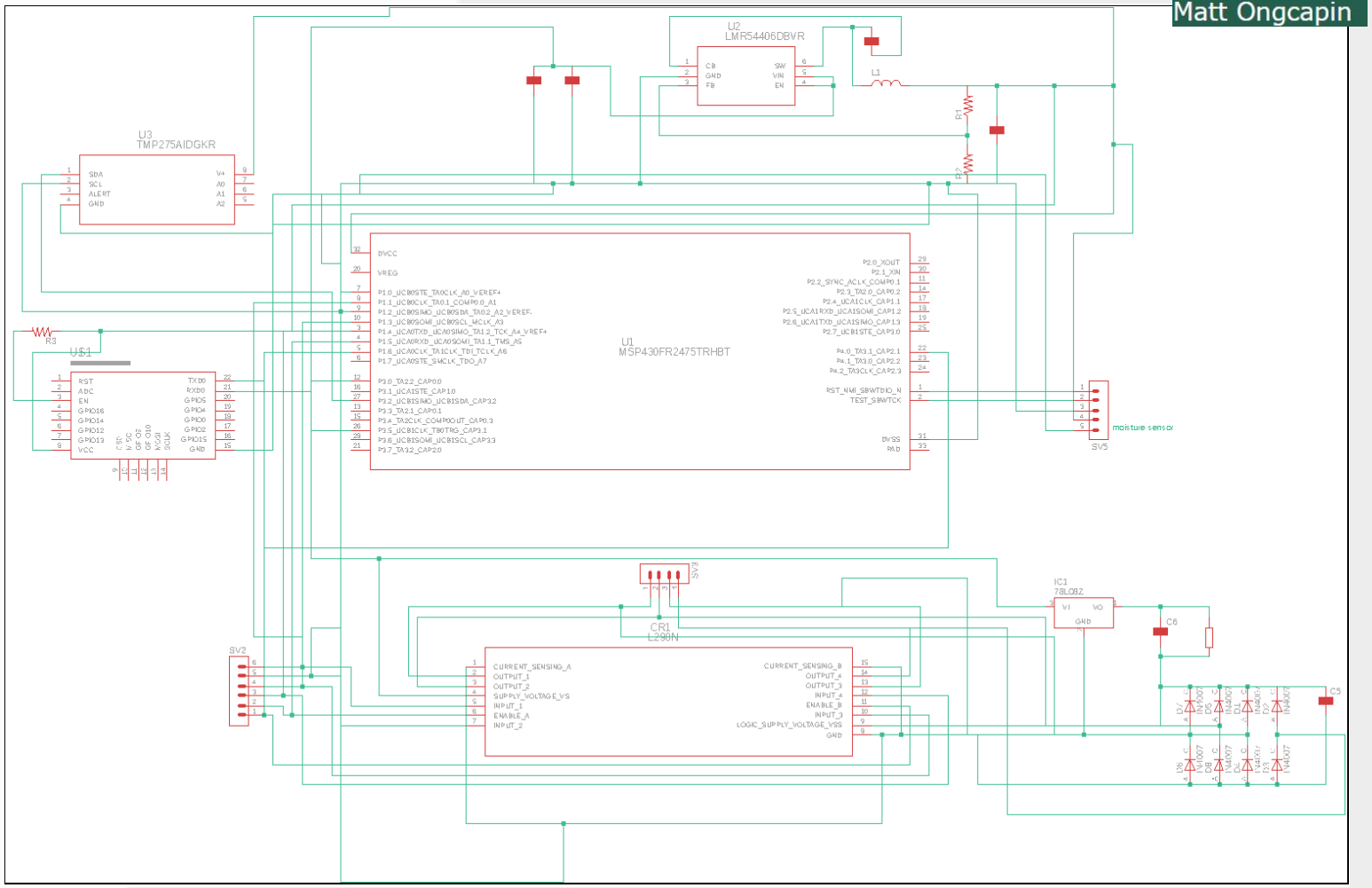
BUCK CONVERTERS

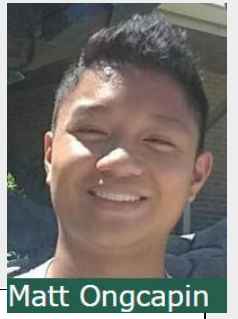
Feature	Valefod	HiLetgo	eBoot Mini
Input Voltage Range (Volts)	3 - 40	4 - 40	4.5 to 28
Output Voltage Range (Volts)	1.5 - 35	1.25 - 37	0.8 - 20
Price Per Unit ($)	1.83	5.25	2.83
Maximum Output Current (Amps)	3	3	3
Operating Temperature (Degrees Celsius)	-45 to 85	Not Listed	-45 to 85

PCB OVERVIEW

PCB

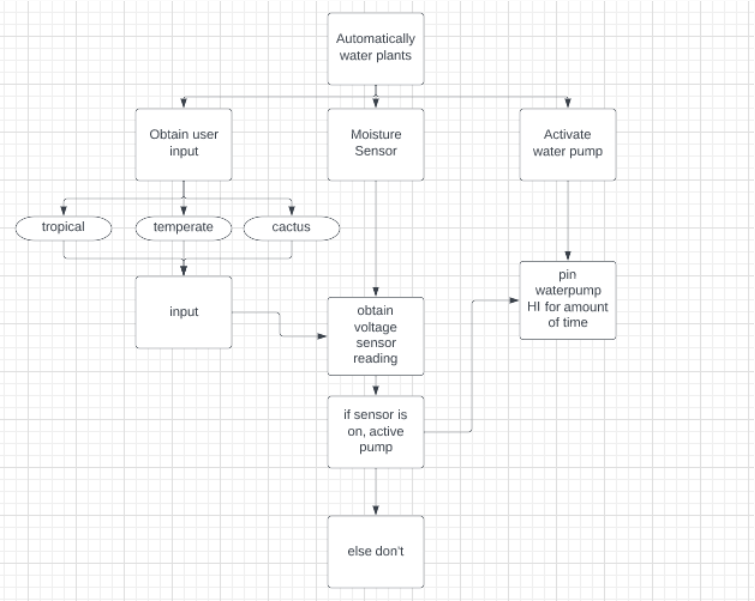

Information Flow
Overview
Website/App
Wi-Fi
Network
Wi-Fi
Temperature
Sensor
I2C
MCU
UART
Wi-Fi Module
Soil Moisture
Sensor
Analog
GPIO/Analog
Motor
Controller

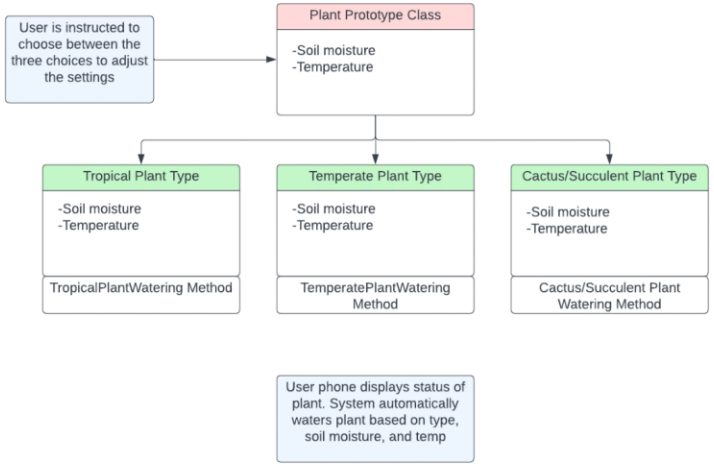

U2
LMR54406DBVR
U3
TMP275AIDGKR
U1
MSP430FR2475TRHBT
R3
U$1
SV5
moisture sensor
SV3
SV2
CR1
L298N
IC1
78L08Z
C6
C5

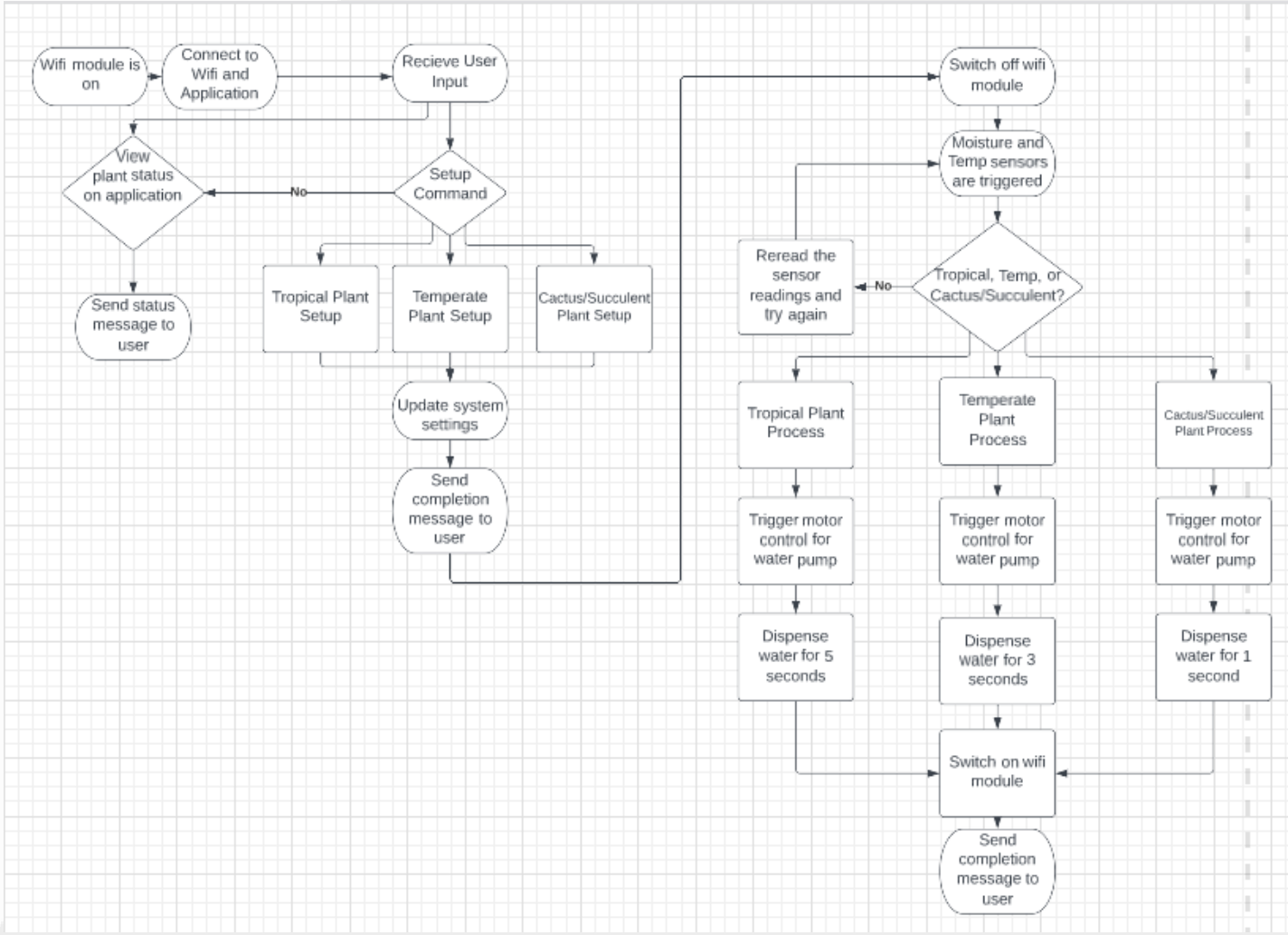

Matt Ongcapin

SOFTWARE SUBSYSTEM

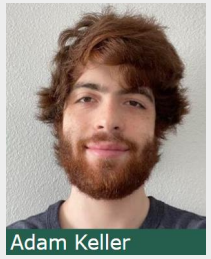
INFORMATION FLOW DIAGRAM





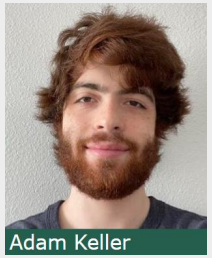


MOBILE APPLICATION



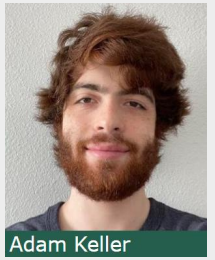
Technologies	Supported Operating Systems	Features	Coding Language	Cost
Flutter	Android and IOS	Hot reload, Open source, and Rich widgets.	Dart	Free
React Native	Android and IOS	Reusable components, Open source and Hot reload.	JavaScript	Free
Swift	IOS Only	Open source, Easy to understand syntax, and Multiple return values.	Swift	Free
Xamarin	Android and IOS	Open Source, Complete development ecosystem, and compatibility.	C#	Free

WEB STACK



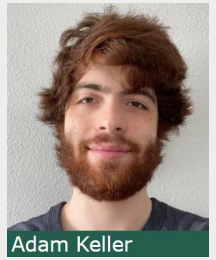
Web Stacks	Technologies	Programming Language	Database	Operating System
MERN	M - MongoDB E - Express.js R - React.js N - Node.js	Javascript frontend and backend	MongoDB	Cross-platform for both windows and linux.
LAMP	L - Linux A - Apache M - MySQL P - PHP or Python	PHP or Python can be used.	MySQL	Linux

DATABASE



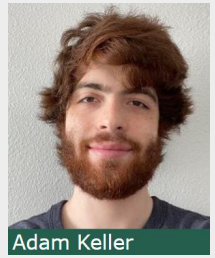
Databases	Data Storage	Key Features	SQL or NoSQL	Data Representation
MySQL	Stored as rows in a table	Supports large databases and is easily scalable for larger applications.	SQL	Rows in a table format
Firebase database	Documents	Realtime database to change values on the fly and Ready-made API.	NoSQL	JSON-like documents
MongoDB	Documents	Horizontal scaling, Simple syntax, and Easy to read JSON like documents.	NoSQL	JSON-like documents

HOSTING PLATFORM

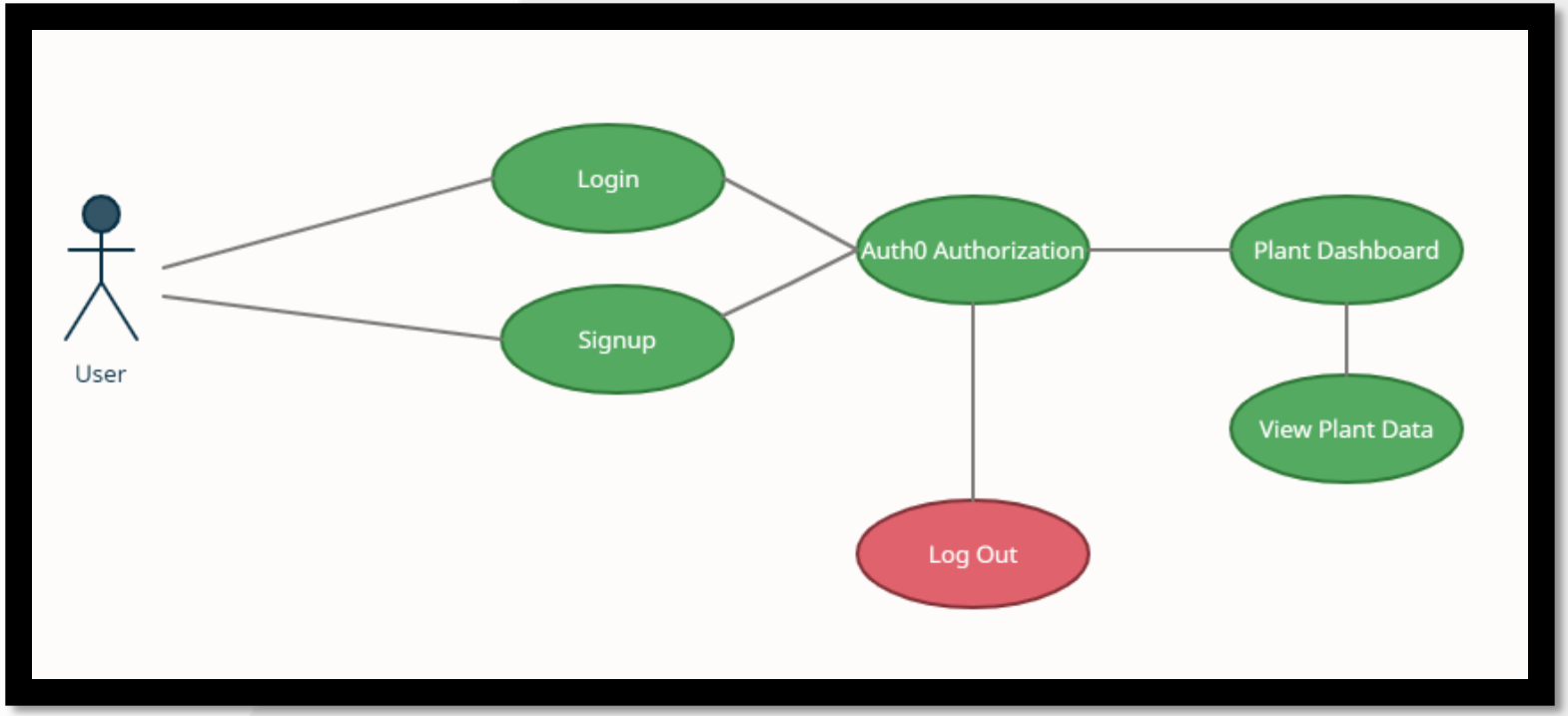


Hosting platforms	Is there a free tier?	Features	Featured Customers	Cost
Heroku	Yes	Automatic scaling and container deployment.	ClickMechanic, ThinkMD, and HotelEngine	Free tier 1) Production - $25 2) Advanced - $250 3) Enterprise - Contact Heroku for custom pricing
Vercel	Yes	Deploys with pushes to the main git branch and supports edge functions.	Facebook, Ebay, and The Washington Post	1) Free tier 2) Pro - $20 a month per member 3) Enterprise - Contact Vercel for custom pricing
Azure	Yes	Cloud computing, High availability, and Cost Effective.	Verizon, MSI Computer, and LG Electronics	1) Free tier 2) Customized price for different services utilized by the customer

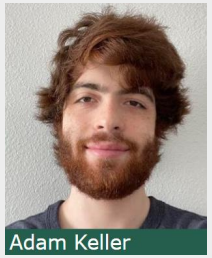
Website/Mobile Application Use Case Diagram



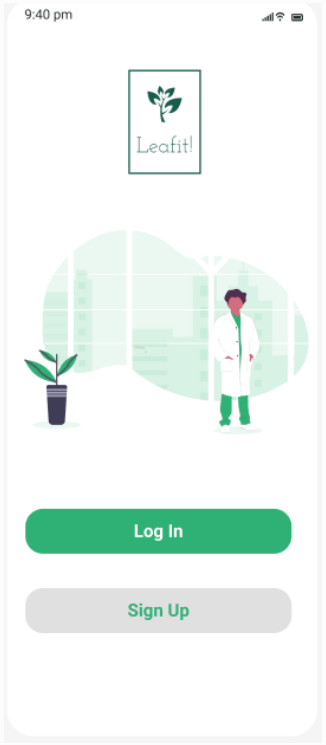
- Website and Mobile application will have a similar user flow shown in the diagram.
- The website will be accessible via cell phones however both Android and Apple devices will have their own dedicated application.

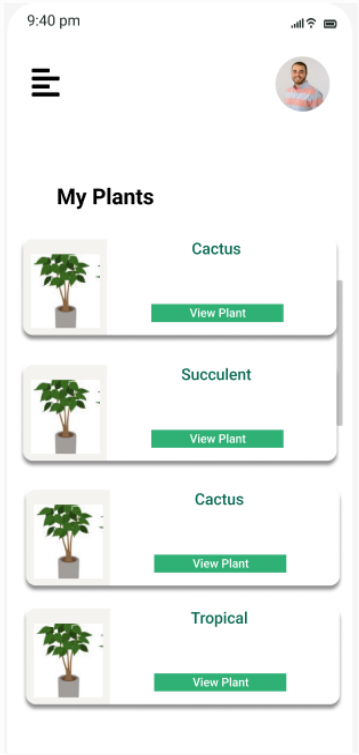


User Interface

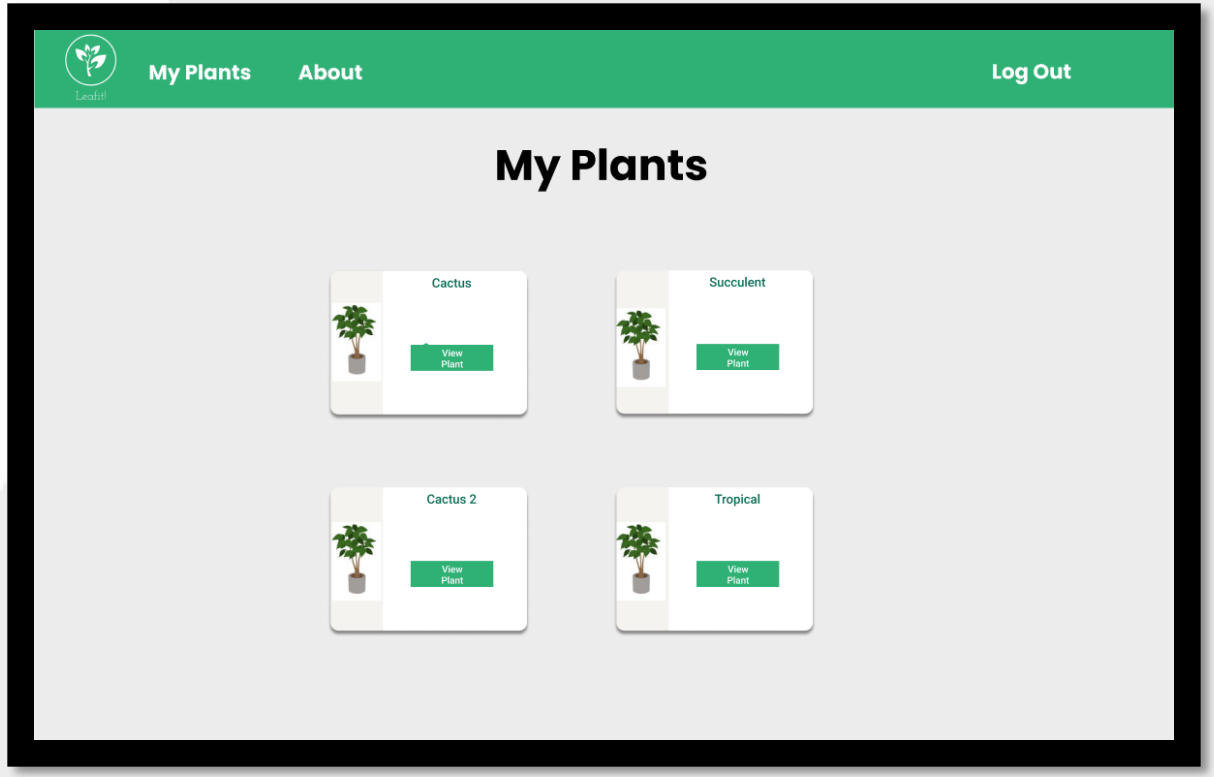


Mobile Application



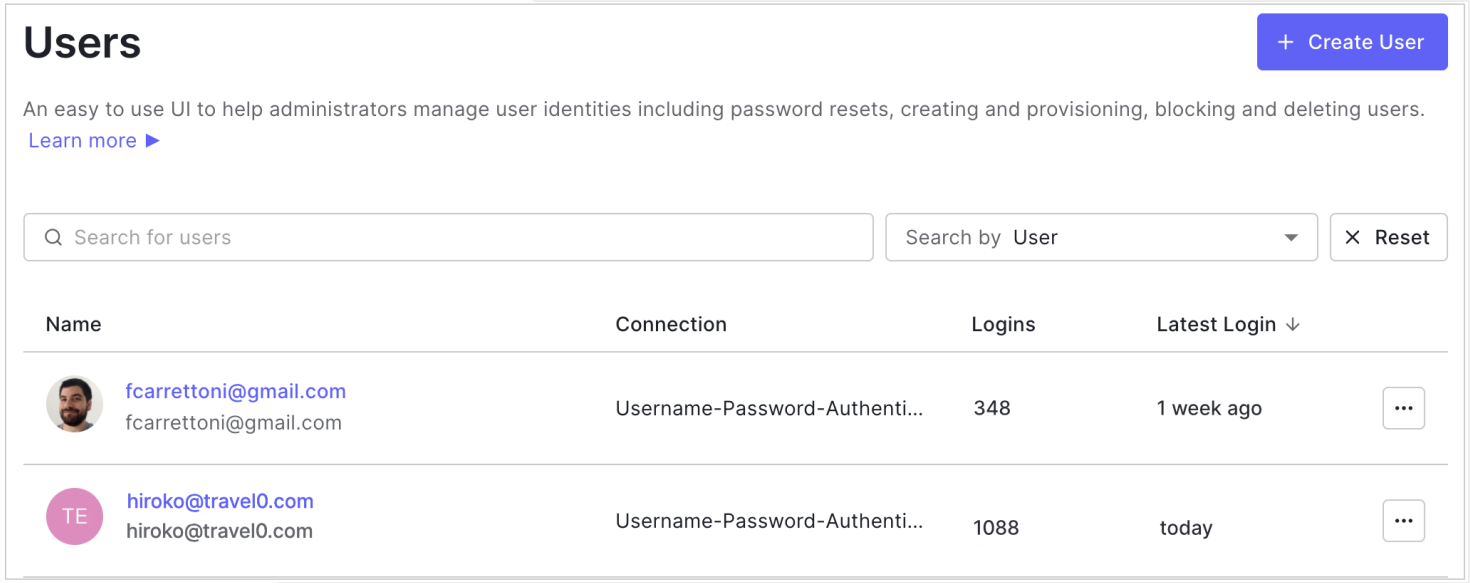


Web Application



User Authentication

- Auth0 to easily authenticate users.
- Built-in integration to login with google account.



Control Software

- Takes user preference data from the web application
- Takes into account sensor data
- Activates the motor controller and pump for a specified amount of time to water the plant

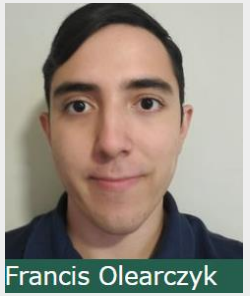
Control Software Components

IDE	Language	Purpose/Features
Repl.it	Python	Rapid prototyping, figuring out algorithmic patterns and software design for functionality
Arduino IDE/Energia IDE	Arduino code/C++	Pre-built functions and libraries for the sensors, team familiarity
Code Composer	C	Energia IDE is not compatible, it is more convenient to code directly on the chip

BUDGET

Part Name	Description	Cost	Quantity	Cost per unit
LM2596	Buck Converter	$10.99	6	$1.83
L298N	Motor Drive Controller Board	$6.99	1	$6.99
Tubing	Penn-Plax Standard tubing	$1.73	1	$1.73
Battery	Tenergy NiMH Battery Pack 12V 2000mAh	$21.99	1	$21.99
Pump	12V Mini Brushless AC Water Pp	$15.96	1	$15.96
Pump and Tubing	Combo pump and tubing kit (3-5V pump) (4 Pumps)	$11.39	4	$2.85
Songhe Camp MS	Soil Moisture Sensor	$10.99	5	$2.20
ESP8266-12F	Wifi Module	$8.99	4	$2.25
TMP275AIDRG4	Temperature sensor	$11.84	2	$5.92
OPT4001YMNR	Light sensor	$11.14	2	$5.57
MSP430FR2475TRHA	MCU	$17.93	3	$5.98
Total		$129.94		$73.26

PLAN FOR COMPLETION



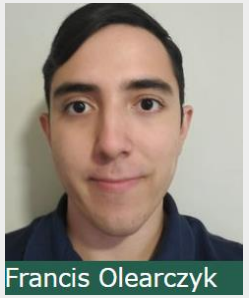
- Hardware – 70%
- Website/App – 80%
- MCU Coding – 70%

- Need to finalize/check first PCB design
- Wrap up website development
- Focus on development for mobile application
- Need to complete the information path from sensors to website

Timeline

Date	Planned Goal
9/16/2022	Configure Hardware (combine motor controller and sensors)
9/23/2022	Implement Arduino Code on MSP430. Order first PCB. Start on Phone App
9/30/2022	PCB Board integration
10/7/2022	Test first PCB/Run Hardware system for extended period
10/14/2022	Create second PCB if required
10/21/2022	Pump and MCU Testing
10/28/2022	Project Testing
11/4/2022	(Maybe third PCB)/Refining
11/11/2022	Testing
11/18/2022	Mock Presentation

Issues that we have run into



- We fried our Wi-Fi chip when we combined the sensor system and the power system
- We have had issues interfacing with components due to the limitations of a breadboard and the small size of some components
- We have had issues with duplicate/faulty libraries.